

# ADAPTATION OF THE LEAN CULTURE TO COLLABORATIVE WORK

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## **Abstract**

In a global world characterized by competitiveness and speed, agility of change represents a key element of success in any organization. Versatility and the capacity of re-adaptation in changing contexts require an acceptance of the reality of the moment and an optimization of the processes within organizations. Given this situation, within the context of Higher Education we asked ourselves if education is adapted to changes, and if students were prepared for market reality. In previous researches we identified that specifically the students of the Degree in Architectural Technology face mixed feelings at the end of their academic stage, specifically during the development of their Final Grade Work. Instead of facing this last phase of the degree with attitude for learning, entrepreneurship, ambition and satisfaction for what has been achieved –that is, attitudes and characteristics of success in the 21st century- we have noticed that a high percentage of this students shows individualism, demotivation, insecurity and fear. According to this situation, as a continuation of previous work this work focuses on the application of business tools that foster the development of attitudes and aptitudes in students of Architectural Technology during the development of the Final Grade Work, bringing them closer to the competitive reality of the current global market. The work is based on the application of tools for improving performance that come from the business sector under the lean manufacturing paradigm applied to the project management and people management and the measurement of these performance indicators. This implementation will allow students to obtain better attitudes and aptitudes in order to achieve the proposed objectives. This application is validated through a case study of a final grade study group. This case study consists of the analysis of behaviors and the evolution of the projects and goals of all the participants during a specific period of time and its variation after the implementation of improvement tools for the project and team management. This evolution is analyzed through specific key performance indicators.

**Keywords:** Lean Education, Collaborative work, High Education, Key performance indicators.

## **1 BACKGROUND**

The current market trend is characterized by turbulent environments under competitiveness and speed. In this context some characteristics such as agility of change represent a key element of success in any organization. Versatility and capacity of re-adaptation in changing contexts require an acceptance of the reality of the moment and an optimization of the processes within organizations. Hence, new waves of paradigms and philosophies are emerging in order to improve quality and business productivity [1]. A previous work of the authors [2] showed how this re-adaptation of competitive models is also translatable to higher education, in order to prepare students for an immediate professional future under the market characteristics specified above. The research was based on the identification and analysis of problems that the students of Architectural Technologist Degree face during the development of their Final Grade Work at the final academic stage. The study case was focused on the experimentation of a group of students with same opportunities and similar characteristics, that is, with the same thematic area of Final Grade Work, the same tutor and identical deadlines. Through this study case the authors identified how a high percentage of these students show individualism, demotivation, insecurity and fear of the development of Final Grade Work, instead of facing this last phase of the degree with concern for learning, entrepreneurship, ambition and satisfaction for what has been achieved up to that time. As a consequence, a solution based on coaching strategies was presented to promote the development of vocational skills and entrepreneurial skills in these students who approach the work environment through the completion of Final Grade Work.

According to this situation, as a continuation of the previous work specified above, this work focuses on the application of business tools that foster the development of attitudes and aptitudes in students

of Architectural Technology during the development of the Final Grade Work, bringing them closer to the competitive reality of the current global market. One of the most representative business trends that improve the performance of organizations is the Lean paradigm. Lean philosophy has its origin in Japan in the manufacturing sector (Lean Manufacturing), specifically in the automotive industry. It was conceived by the director of the Toyota company Taiichi Ohno, who was also the creator of the Toyota Production System [3] as a consequence of the unsuitability of production systems based on Frederick Taylor and Henry Ford mass production model. Subsequently, the term Lean was coined by James P. Womack and Daniel T. Jones Lean Thinking [4] as a business methodology applicable to any organization seeking operational excellence, transforming the company as a whole and allowing not only the customer satisfaction but also of the workers. Although originally its application began in the manufacturing industry, specifically in the automotive sector, it has been covering new fields of application, being adapted to other industries and sectors through different techniques and tools such as Kaizen, or Just in Time (JIT), among others.

One of the most relevant applications of the Lean philosophy is the evolution of this new management philosophy to the construction industry, which has been adapted as Lean Construction [5-7]. The aim of Lean Construction is to improve the construction project workflow, creating customer value while eliminating or minimizing waste, which means in the Lean jargon, activities that do not add value to the process. In addition, its application in other areas has been extended to improve the performance of any type of organization through a change of mentality under the approach of continuous improvement, customer satisfaction and waste reduction. As an example of the diversity in its application is its implementation in various areas such as Lean Startup, Lean Healthcare, Lean Logistics, Lean Government, Lean Management, Lean Services, Lean Accounting, Lean Software Development, or Lean Higher Education, etc....

This project is based on the latter application related to Lean Higher Education. Some examples applied to Lean Education have been found in the literature, in [8] is presented the use of a Lean model as a means of transforming the university system at the College of Engineering at the University of Tennessee at Chattanooga. In the same line, the application of Lean Six Sigma (LSS) is presented in [9], as a methodology for improving business processes in order to increase the efficiency and effectiveness of higher education institutions. Also in [10] Lean techniques are applied for the improvement of university processes. Although all of them are focused on the application of Lean to improve university processes from the organizational point of view of the institution, none is focused on the application of Lean in the learning process.

Therefore, the present work is based on the application of Lean tools in the field of learning process in Higher Education. The main objective of the research is to foster students to obtain better attitudes and aptitudes at the last stage of their academic studies. Specifically, it is focused on improving performance through the use of tools that come from the business sector under the lean manufacturing paradigm applied to the project management and people management.

## **2 METHODOLOGY**

The present work focuses on the practical application of agile management methodologies under the Lean paradigm during the development of different Final Grade Works. The case study includes the application of work methods in order to achieve individual and global objectives in an effective and efficient way. The experimentation was carried out in a work group composed by five students.

The following methodology (Figure 1) included the initial phase of barrier identification developed in a previous research and its continuation, which corresponded to the application of lean tools, representing the core of this research. The proposal of application of Lean solutions included the identification of tools and the application of the most suitable ones. A final stage of the research followed the bases of the Lean methodology; a last retrospective phase was established to cyclically close the process, facilitating continuous improvement.

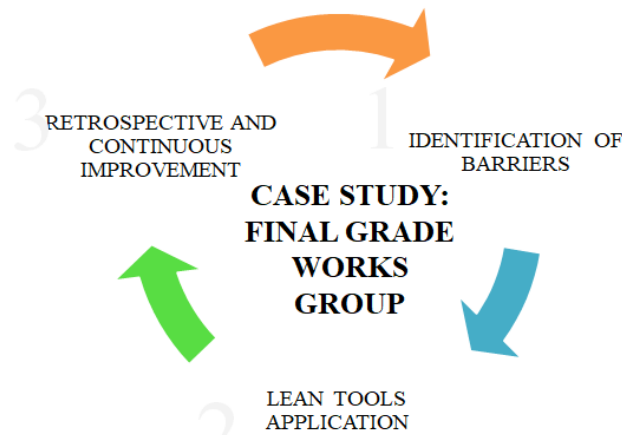


Figure 1. Research methodology

### 3 CASE STUDY: APPLICATION OF LEAN SOLUTIONS

In contrast to a traditional system, a system under the Lean approach is based on improvement through fundamental aspects such as management of people, quality management and production management (Figure 2).

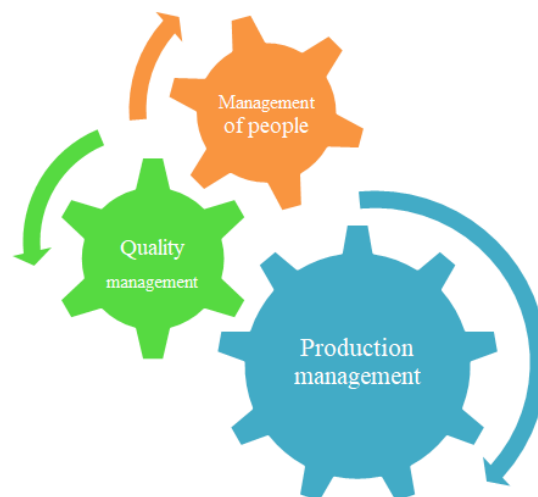


Figure 2. Lean approach as engine of change

The Management of People under the Lean approach includes motivation, collaboration and cooperation, transparency and fluidity of information as a fundamental basis. Another essential aspect in the Lean system is the Quality Management based on the improvement of the system with the participation of all the participants, encouraging the self-critical feeling, the organizational identity and the feeling of belonging and contribution to the same. In addition, another relevant aspect of the Lean paradigm is the Production Management through improving the overall performance of the organization, aligning objectives and maximizing activities that contribute value and reducing or eliminating those that do not add value to the production process [11].

From the weaknesses and barriers detected in a previous research, the present case study of the Final Grade Works, analyses the possible Lean solutions that could help the work group to eliminate the common feeling of individualism, demotivation, insecurity and fear of the students of Final Grade Work.

Among all the Lean tools analyzed the group assigned the most suitable ones to be applied during all sessions of the Final Grade Work group (Table 1).

**Table 1.** *Lean tools applied in the case study*

LEAN TOOLS APPLIED IN THE CASE STUDY	Features managed under the Lean approach in the project		
	PEOPLE	QUALITY	PRODUCTION
Adaptation of the last planner system	✓		✓
PPC- Percent Plan Complete		✓	✓
Value Stream Mapping			✓
Plus/Delta List		✓	
5 Why'S		✓	
Coaching	✓		
Collaborative Work Environments	✓		✓

Among those related to the management of the participants in the sessions - the 5 students and the group tutor together with all of the guest teachers who participated in the different session to contribute ideas and participate in the brainstorming group - identified 3 tools for their application during sessions (Table 1).

These tools were the Adaptation of the Last Planner System to the management of the work group of Final Grade Works. Last Planner System is a tool within the application framework of Lean Construction for the creation of customer value while minimizing waste from execution improving the workflow. Last Planner System is characterized by the generation of a predictable workflow through a collaborative planning process distinguished by participant commitment and agility. Glenn Ballard was the creator of Last Planner System along with Greg Howell defining it as a set of tools that houses a philosophy, rules and procedures for the proactive management of the production process [12]. To do this, several Last Planner System elements are established in different time horizons throughout the management of the construction project: Master schedule, Phase Scheduling also known as Pull schedule, Look Ahead Planning and Weekly Work Plan [7, 13-15]. Instead of management of construction projects, it was carried out an adaptation of the system Last Planner System was applied to the management of all Final Grade Works.

A second tool related to the management of people is coaching. Coaching is a tool whose success has been widely validated in other fields such as business or sports, which acts as a driver of change, allowing the optimal performance and improvement of professional results both individual and group through techniques of analysis and motivation. Finally, in the group of tools used in the project for the management of people, collaborative work environments were used to promote collaboration and cooperation, transparency and information flow. Specifically, Trello was used as adequate software for the management of all projects so that each participant had access to the material, project and comments of the tutor of each of the participants (Figure 3). This fact gave confidence in the group avoiding misgivings and adversities.

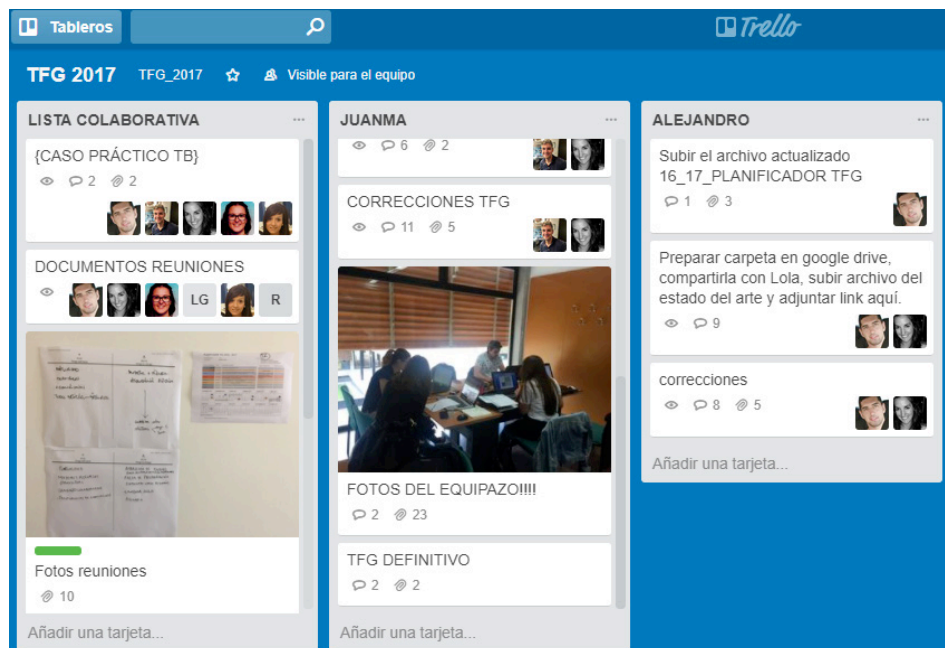


Figure 3. Collaborative work environments of Final Grade Work group through Trello

In parallel, as it is shown in Table 1, Lean tools related to quality management were used. Some of these tools were: PPC-Percent Plan Complete, List Plus / Delta and the 5 Why's tool, being PPC a Percentage Completion Plan indicator that evaluates the performance of the activities programmed in the Final Grade Works Planner (Figure 4).

#### PLANIFICADOR TFG 2016 - 2017

PROYECTO/EVENTO	TFG	Eventos programados:
ORGANIZADOR	JUAN MANUEL VENTURA RUIZ	<ul style="list-style-type: none"><li>REUNIÓN INICIAL 4 NOVIEMBRE</li><li>CURSO MENDELEY 2 HORAS 18 NOVIEMBRE</li><li>6 REUNIONES A LO LARGO DEL CURSO ACADÉMICO</li></ul>

REUNIONES PROGRAMADAS	FECHA	CONTENIDOS REUNIÓN	TAREAS PENDIENTES	RAZONES DE NO CUMPLIMIENTO
REUNION INICIO	04.11.2016	Concretar en reunión propuestas TFG	-	-
CURSO MENDELEY 2H	18.11.2016	Conocer gestores bibliográficos para el proyecto y búsqueda de información	ASISTIR AL CURSO	
REUNION 1	02.12.2016	Traer a la reunión borrador del Estado del Arte, ¿qué existe sobre tu tema TFG a nivel científico y académico? / Sesiones colaborativas	EXPLICAR EN 5' TEMA TFG Y QUE HAYEN INTERNET SOBRE EL TEMA	
REUNION 2	27.01.2017	Traer a la reunión borrador de los objetivos, la metodología y el plan de trabajo e inicio del cuerpo del trabajo. Traer las correcciones al Estado del Arte tras REUNION 1 / Sesiones colaborativas	ACABAR CON EL ESTADO DEL ARTE	EXAMENES1º CUATRIMESTRE
REUNION 3	24.02.2017	Traer a la reunión borrador del cuerpo del trabajo. Traer las correcciones del borrador tras REUNION 1 y 2 / Sesiones colaborativas	COMENZAR CON EL CUERPO DEL TRABAJO	DEMASIADA CARGA DE TRABAJO (LABORAL)
REUNION 4	17.03.2017	Traer a la reunión conclusiones y bibliografía. Correcciones borrador tras REUNION 1, 2 y 3 / Sesiones colaborativas	COMENZAR CON EL CASO PRACTICO	
REUNION 5	07.04.2017	Traer borrador definitivo y ENTREGA A LOLA para corrección		
REUNION 6	12.05.2017	ENTREGA FINAL A LOLA para corrección definitiva y firma de informe del tutor		

NOVIEMBRE 2016	DICIEMBRE 2016	ENERO 2017	FEBRERO 2017	MARZO 2017	ABRIL 2017
D L M X J V S	D L M X J V S	D L M X J V S	D L M X J V S	D L M X J V S	D L M X J V S
1 2 3 4 5	1 2 3	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4	1
6 7 8 9 10 11 12	4 5 6 7 8 9 10	8 9 10 11 12 13 14	5 6 7 8 9 10 11	5 6 7 8 9 10 11	2 3 4 5 6 7 8
13 14 15 16 17 18 19	11 12 13 14 15 16 17	15 16 17 18 19 20 21	12 13 14 15 16 17 18	12 13 14 15 16 17 18	9 10 11 12 13 14 15
20 21 22 23 24 25 26	18 19 20 21 22 23 24	22 23 24 25 26 27 28	19 20 21 22 23 24 25	19 20 21 22 23 24 25	16 17 18 19 20 21 22
27 28 29 30	25 26 27 28 29 30 31	29 30 31	26 27 28	26 27 28 29 30 31	23 24 25 26 27 28 29

Figure 4. Goals and commitment, constraints and PPC calculation in the Last Planner System adaptation.

The PPC allowed obtaining a comparison between the initial schedule and goals and what actually was achieved. Furthermore, to learn from the mistakes made and foster the continuous improvement it was used the 5 Why's tool to detect the root cause of the reasons of non-fulfilment for the objectives set in the Final Grade Works Planner (Figure 4). Finally, the elaboration of Plus / Delta Lists in a group way, through an A3 place on the wall of the room in each session, allowed to streamline and improve each of the Final Grade Works sessions from a quick and simple retrospective.

Finally, among the tools related to the management of production itself, Table 1 shows the tools used to adapt to Last Planner System and PPC already defined above, and the Value Stream Mapping tool,

is a tool used in Lean to analyse the flows of materials and information that are required to make a product or service available to the customer. From the creation of a map of all phases of the process, potential improvements are identified and evaluated. In the Final Grade Works group the tool was used to visualize the interferences between the works and to detect possible interferences and delays.

## 4 RESULTS

From the implementation of the various Lean tools shown in the previous section, the results obtained after their implementation are the following:

- The implementation of the Last Planner System system allowed the management of all the works supervised by the same tutor in a coordinated and synchronized way in order to meet objectives. Moreover, it served as a tool for gamification so that the students knew in a simple and easily understandable way how a construction project is managed under the lean approach, specifically under the Last Planner System system. The tools associated to Last Planner System like 5 Why's and PPC allowed to obtain a comparison between what was schedule and what actually was executed, learning from the mistakes made and fostering the continuous improvement.
- The collaborative work environment through the use of the Trello tool to manage all the projects together facilitated to the participants the access to all the content, material, project and comments of the tutor of each of the participants uploaded to Trello. This fact strengthened trust among the work group avoiding misgivings and adversities.
- The elaboration of Plus / Delta Lists in a group way, through an A3 place on the wall of the room in every session, allowed to streamline and improve each of the Final Grade Work sessions from a quick and simple retrospective as shown in Figure 6.

## 5 CONCLUSIONS

According to the results obtained, it is shown that the application of Lean tools during the management of the Final Grade Work group has had satisfactory results on the objectives to be achieved with 100% of project deliveries in the ordinary deadline of June. All students who participated in the group were able to deliver the Final Grade Work in the planned deadline, overcoming feelings of individualism, demotivation, insecurity and fear and transforming them into motivation, collaboration, optimism, confidence and willingness to improve.

In addition, results of project deliveries were compared between the teachers who participated in the research; and it was reaffirmed that the application of Lean tools in the management of Final Grade Projects improves student's performance and reduces the workload of the tutor, avoiding deliveries at the last moment without periodic control, facilitating the correction and reading of the works throughout the academic year.

## ACKNOWLEDGEMENTS

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